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10. Data Report: Silica Mineral Crystallization with Textural Change of Cretaceous Siliceous/Calcareous Pelagic Sedimentary Rocks Recovered from the Northwest Pacific, ODP Leg 185[1]

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INTRODUCTION

Siliceous pelagic sediments have been known to be crystallographically altered during burial diagenesis (e.g., Hesse, 1990; Behl and Smith, 1992). In order to know the systematic downhole change of silicification, sediments from Pacific Ocean crust obtained during Ocean Drilling Program Leg 185 Site 1149 (Plank, Ludden, Escutia, et al., 2000) were analyzed. For collected samples of Early Cretaceous age below the pelagic sediments, which are not as highly silicified, silica mineral crystallization in the siliceous sedimentary rocks is determined by X-ray diffraction (XRD), and the related textural change is shown by using scanning electron microscope (SEM).

METHODOLOGY

All analyses were conducted at the University of Tsukuba, Japan, in 2000. For each sample, thin sections were made mostly perpendicular to the bedding, which is marked by thin lamination. When more than one thin section was made from a sample, these were independently numbered and labeled as individual specimens (Table T1). Another portion of the sample was partly powdered for XRD analysis, and the rest

T1. Sample data, p. 11.

[1]Tanaka, C., and Ogawa, Y., 2006. Data report: Silica mineral crystallization with textural change of Cretaceous siliceous/calcareous pelagic sedimentary rocks recovered from the northwest Pacific, ODP Leg 185. *In* Ludden, J.N., Plank, T., and Escutia, C. (Eds.), *Proc. ODP, Sci. Results,* 185, 1–11 [Online]. Available from World Wide Web: <http://www-odp.tamu.edu/publications/185_SR/VOLUME/CHAPTERS/004.PDF>. [Cited YYYY-MM-DD]
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of the fragments were etched by diluted HF for several hours for surface observation by SEM. XRD analysis was done using CuK_α radiation with 2θ = 1 min, voltage = 40 kV, and current = 20 mA, from 50°2θ to 3°2θ. The range from 69°2θ to 67°2θ was used for identification of silica crystallinity index after Murata and Norman (1976) as

$$10 \times \mathrm{F} \times a/b,$$

where

F = 1.4 (tentatively),
a = peak length at (212), and
b = a – background height from the quintuplets for opal-CT and quartz rocks.

A standard sample of Brazilian quartz was used as the index = 10. The d(101) spacing of cristobalite for each part of the sample was also obtained.

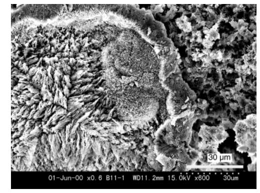
Representative SEM photos are shown in Figures F1, F2, F3, F4, and F5, and the silica crystallinity index, d(101), and other data relevant to the sample reported in Shipboard Scientific Party (2001) are shown in Table T1. A diagram of crystallinity index and porosity is shown in Figure F6.

RESULTS

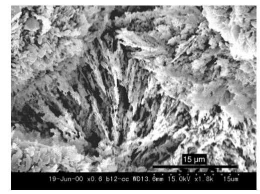
Samples cored below 180 meters below seafloor (mbsf) and belonging to lithologic Units III and IV were determined shipboard to be composed of biogenic siliceous, partly calcareous, pelagic sedimentary rocks of Early Cretaceous age (Plank, Ludden, Escutia, et al., 2000; Shipboard Scientific Party, 2001). It has been reported that Mesozoic pelagic siliceous sediments are altered or recrystallized from porcellanite to chert with increasing depth in association with a silica phase change from opal-CT to quartz (e.g., Hesse, 1990; Behl and Smith, 1992). As a result, this tendency was generally expected in our samples. Silica crystallinity index and opal-CT d(101) spacing from XRD data (Fig. F6; Table T1) indicate that although locally the silica phase decreases downhole, the general trend is a downhole increase of the crystallinity index and spacing. The high values are generally constant between just above 180 and 368.89 mbsf in Hole 1149B, with an average value for this interval of 1.48. Maximum values of the crystallinity index within this interval (i.e., 2.31) are attained at 179.51 mbsf. From 387.74 mbsf, there is a sudden increase of the silica crystallinity index values with a maximum value of 3.91 at 387.74 mbsf and an average value of 3.06. The crystallinity index values are variable between Holes 1149B, 1149C, and 1149D (Table T1), but the general increase of crystallinity index with depth is recognized (Fig. F6).

The increase in silica crystallinity was also confirmed in the textural and mineralogical changes seen in the SEM photos. In Hole 1149B, samples taken between 180 and 245.40 mbsf have both opal-CT and quartz (chalcedony) in the cavities of sediments, as well as in the cavities of radiolarian tests. The latter is dominant downhole (Figs. F1, F2, F3), but below 387.74 mbsf, most cavities are filled with quartz (chalcedony) (Figs. F4, F5).

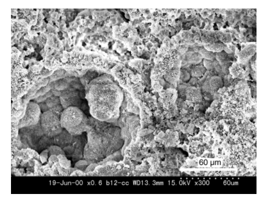
F1. Opal-CT lepisphere with quartz, p. 5.



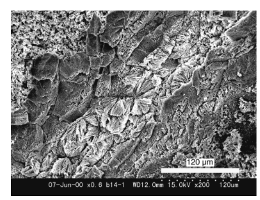
F2. Quartz in radiolarian test cavities, p. 6.



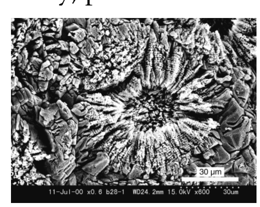
F3. Opal-CT in radiolarian test cavities, p. 7.



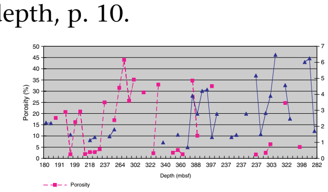
F4. Quartz occupying radiolarian test, p. 8.



F5. Microcrystalline quartz and chalcedony, p. 9.



F6. Porosity and silica index vs. depth, p. 10.



Porosity and other logging data can also be correlated with those tendencies of silica crystallization (Table T1). Sporadic increases in porosity in opposition to crystallinity increases are attributed to dehydration and associated cavity increases as opal-CT converts to quartz, as well as within the quartz zone.

The obtained X-ray data are listed in Table T1 together with porosity data obtained during Leg 185 (Plank, Ludden, Escutia et al., 2000). The low values in Table T1 may be generally attributed to the higher crystallinity minerals (opal-CT and quartz) in the cavities of the sedimentary rocks. Such increase of index and crystal growth may be due to burial diagenesis.

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Figure F1. Opal-CT lepisphere in the center with quartz (chalcedony) on the left in a radiolarian test (Sample 185-1149B-11R-1, 23–26 cm; 236.53 mbsf).

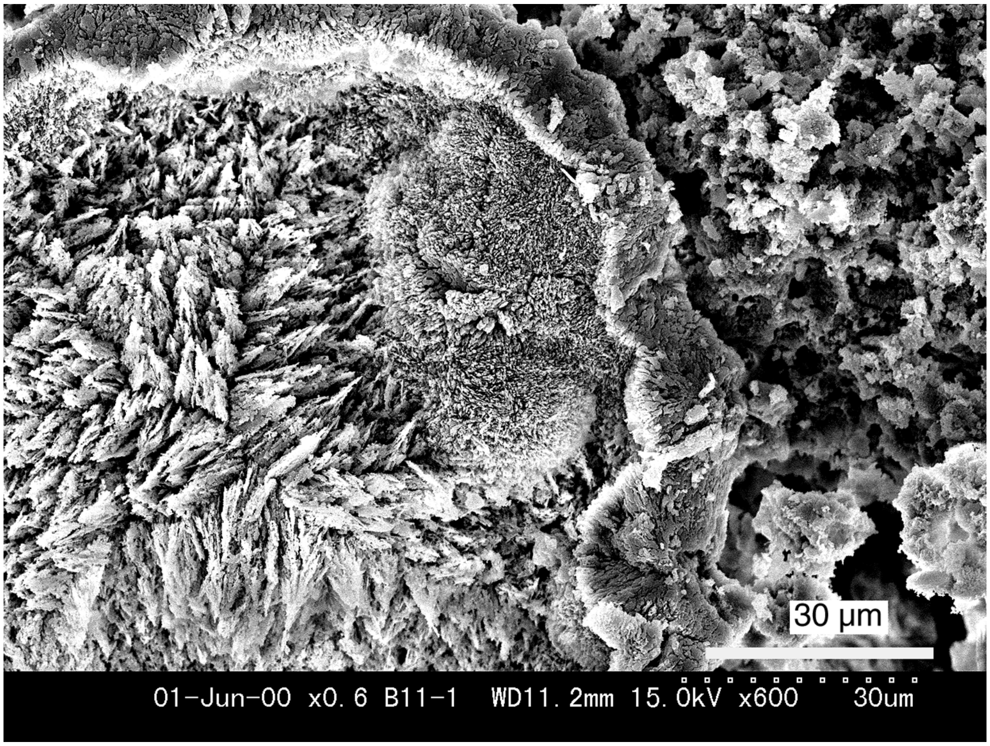

Figure F2. Quartz (chalcedony) occupying the cavities between radiolarian tests (Sample 185-1149B-12R-CC, 0–3 cm; 245.40 mbsf).

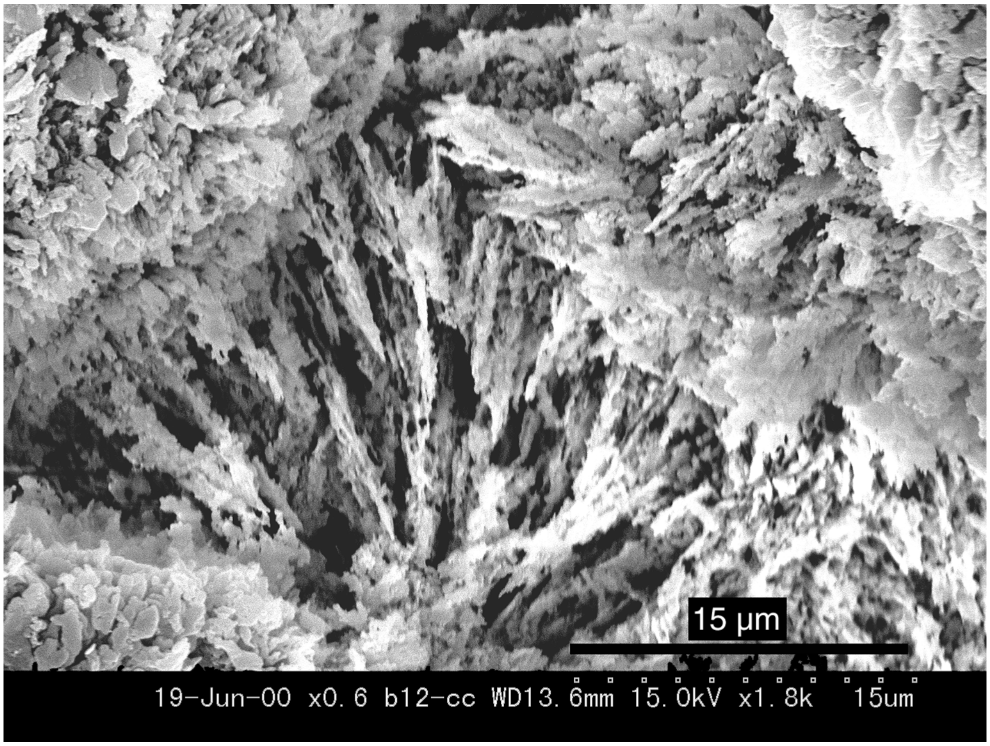

Figure F3. Opal-CT lepisphere occupying the cavities of radiolarian tests (Sample 185-1149B-12R-CC, 0–3 cm; 245.40 mbsf).

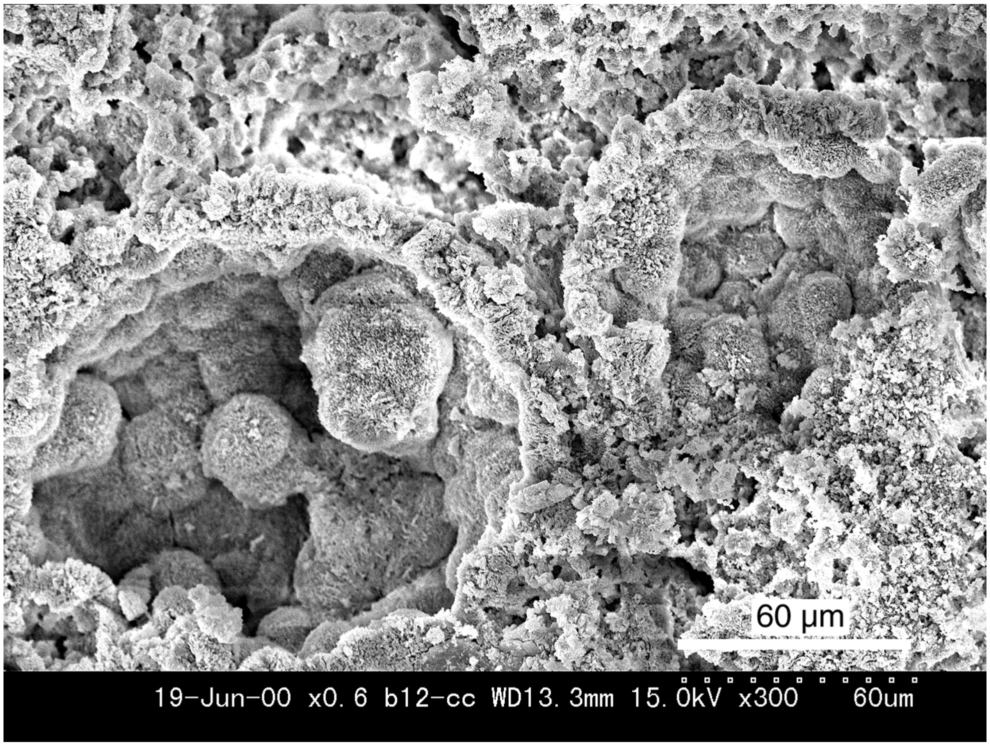

Figure F4. Quartz (chalcedony) occupying a radiolarian test (Sample 185-1149B-14R-CC, 0–4 cm; 263.90 mbsf).

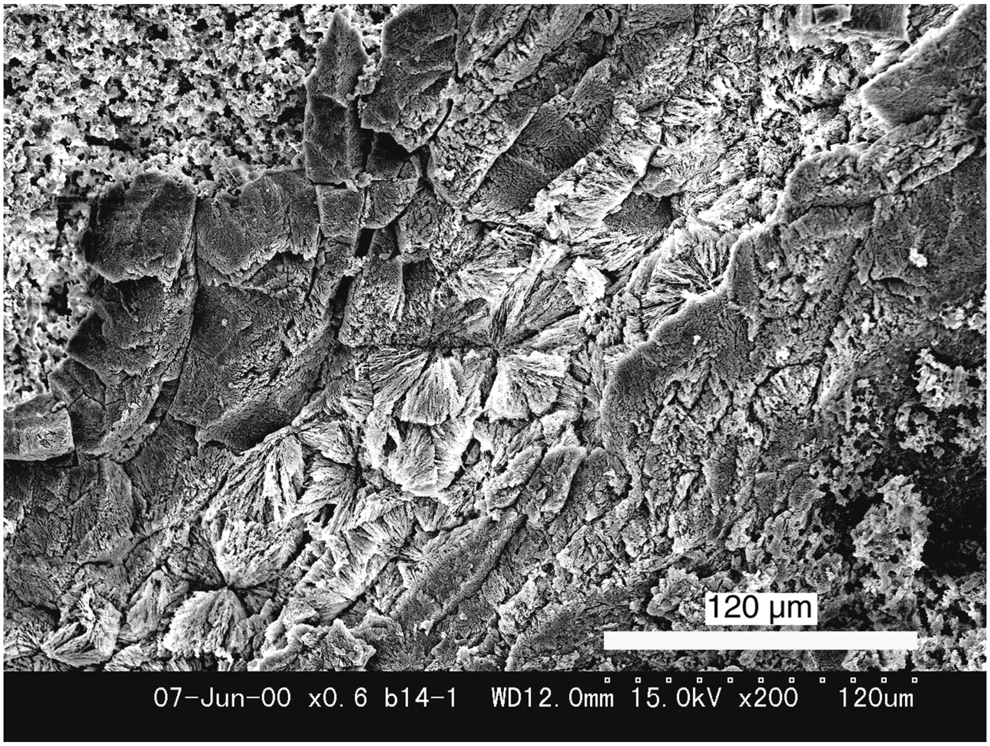

Figure F5. Microcrystalline quartz and chalcedony in the calcareous laminae (Sample 185-1149B-28R-1, 9–11 cm; 397.19 mbsf).

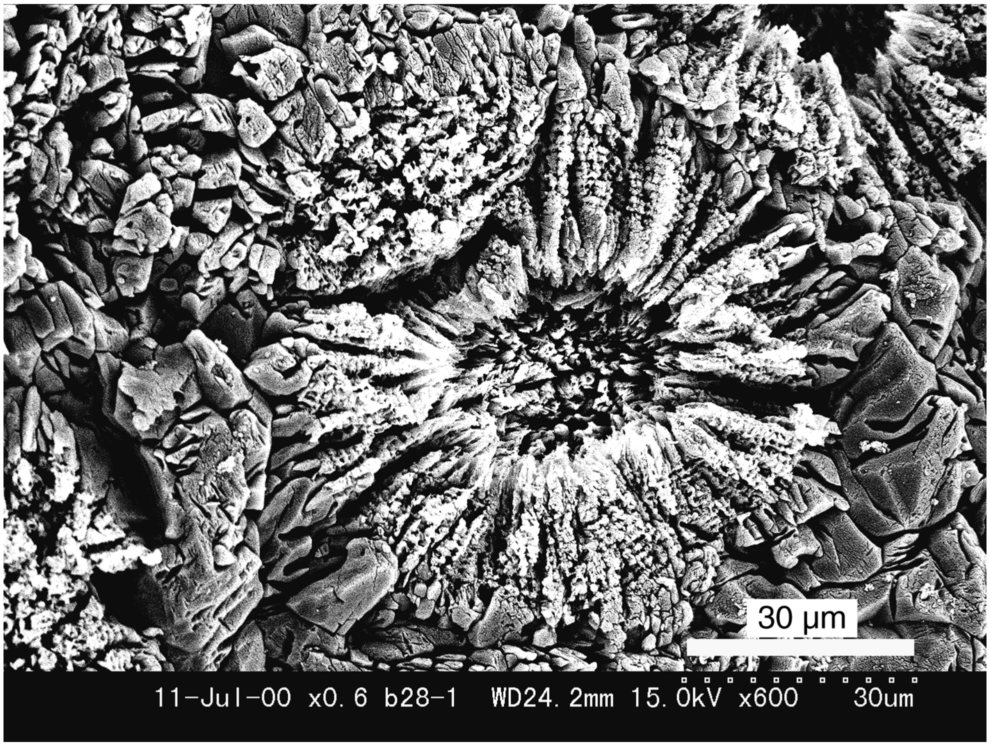

Figure F6. Diagram of porosity (after Shipboard Scientific Party, 2001) and silica index (obtained in this study) vs. depth.

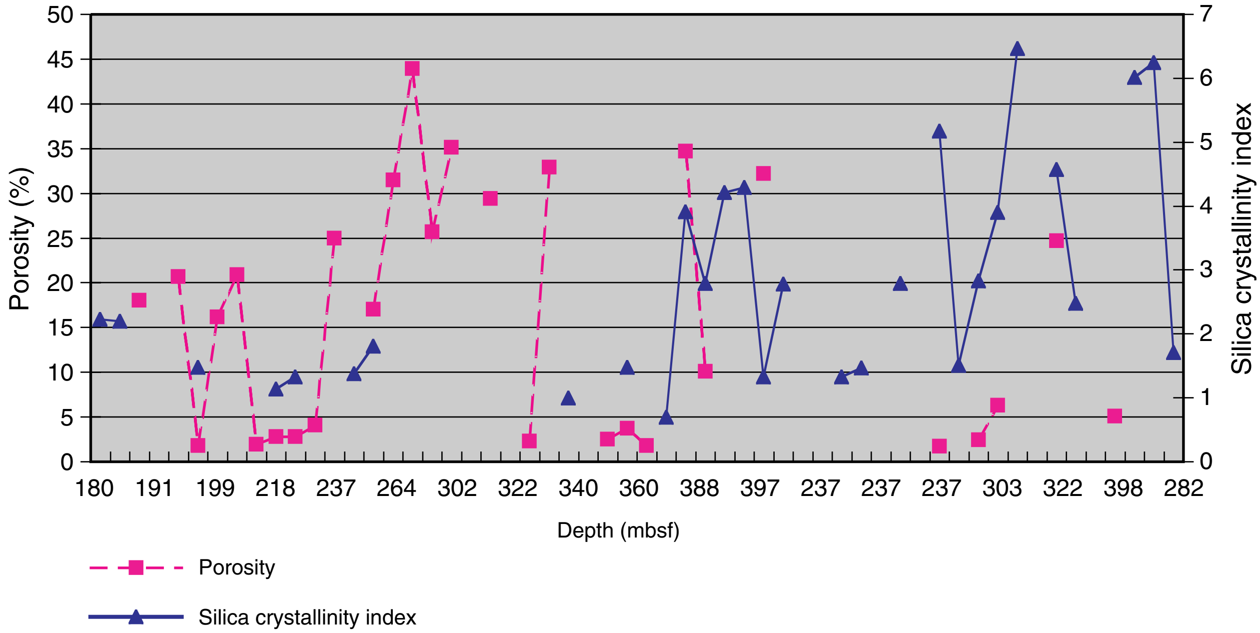

Table T1. Sample data, Brazil quartz.

Core, section, interval (cm)	Depth (mbsf)	d(101) 2θ	GRA density (g/cm³)	Porosity* (%)	CI†
185-1149A-					
21R-CC, 41–43	179.51	21.75	1.42		
21R-CC, 41–43	179.51	21.7			
21R-CC, 41–43	179.51	21.7			
21R-CC, 41–43	179.51	21.6			2.31
21R-CC, 41–43	179.51	21.7			2.22
23R-1, 2–5	190.92	21.9		18.00	
23R-1, 2–5	190.92	21.9			
185-1149B-					
4R-1, 22–24	180.22	21.7		20.70	
4R-1, 22–24	180.22	21.85	1.28		
4R-1, 22–24	180.22	21.8			
4R-1, 22–24	180.22	21.85			
5R-1, 4–8	189.44		2.30	1.80	1.48
6R-1, 30–33	199.00	21.8	1017.00	16.20	
6R-1, 30–33	199.00	21.8			
7R-1, 8–37	203.78	21.85	1.54	20.90	
7R-1, 8–37	203.78	21.75			
7R-1, 8–37	203.78	21.75			
8R-1, 10–13	208.20		0.82	1.90	
9R-1, 19–25	217.59		1.79	2.80	1.13
9R-1, 34–37	217.74				1.32
10R-1, 12–14	226.92		1.65	4.10	
10R-1, 12–14	226.92				
11R-1, 23–26	236.53	21.85	1.38	25.00	
12R-CC, 0–32	245.40	21.8			1.37
13R-1, 6–10	254.66	21.75		17.00	1.81
14R-1, 0–4	263.90	21.8		31.50	
16R-1, 55–57	282.85	22	1.43	43.90	
17R-1, 5–8	292.05	21.8	1.12	25.70	
18R-1, 63–65	301.75		1.57	35.10	
18R-1, 63–65	301.75				
19R-1, 29–32	311.59		1.37	29.40	
20R-1, 94–100	321.84				
21R-CC, 11–13	330.61			2.30	
22R-1, 32–35	340.42		1.15	32.90	
22R-1, 32–35	340.42				0.99
22R-1, 32–35	340.42				
23R-1, 3–7	349.73		0.75	2.50	
23R-1, 3–7	349.73				
23R-1, 3–7	349.73				
24R-1, 31–33	359.51		1.88	3.70	1.48
24R-1, 31–33	359.51				
25R-1, 19–23	368.89		1.10	1.80	
25R-1, 19–23	368.89				0.69
26R-1, 39–44	378.49		1.47	4.10	
27R-1, 14–16	387.74		1.72	34.70	3.91
27R-1, 14–16	387.74				2.16
28R1, 9–11	397.19		1.70	10.10	2.79
28R-1, 9–11	397.19				4.21
28R-1, 9–11	397.19				4.28
28R-2, 127–130	398.78		1.60	32.20	1.32
28R-2, 127–130	398.78				2.77
29R-1, 61–64	407.41			23.70	
185-1149C-					
1R-1, 98–104	237.00				
1R-1, 98–104	237.00	21.75			
1R-2, 7–10	237.00				1.32
1R-2, 7–10	237.00	22.1			1.46
2R-1, 24–31	237.24	22.1			
2R-1, 24–31	237.24	21.95			2.78
2R-1, 24–31	237.24	21.8			
3R-1, 54–58	284.14	22		44.10	
4R-1, 21–24	293.41			1.70	5.17
4R-1, 21–24	293.41				1.50
5R-1, 7–19	302.87		1.43	2.40	2.82
6R-1, 34–42	312.74		1.76	6.30	3.90
6R-1, 34–42	312.74				6.46
7R-1, 107–110	322.00				
7R-1, 107–110	322.00				
7R-1, 107–110	322.00				
8R-1, 107–110	390.00				4.57
8R-1, 107–110	390.00				2.48
9R-1, 27–29	398.17				
9R-1, 27–29	398.17				
9R-1, 27–29	398.17				
185-1149D-					
2R-1, 23–26	272.43			5.10	
2R-1, 23–26	272.43				6.01
3R1, 5–7	281.65				6.23
3R-1, 5–7	281.65				1.70
4R-1, 49–51	291.34		1.06	2.20	
4R-1, 49–51	291.34				
5R-1, 14–15	300.44		2.24	8.00	

Notes: CI = silica crystallinity index. * = Shipboard Scientific Party (2000), † = obtained in this study.